

Claims

- [c1] An automated manufacturing line for making a composite article from first and second thermoformed workpieces by automatically assembling the first thermoformed workpiece to the second thermoformed workpiece, comprising:
- a thermoforming station for thermoforming the first and second thermoformed workpieces in a plastic sheet;
 - a trim station for trimming at least the first thermoformed workpiece from the plastic sheet; and
 - an assembly station for assembling the first thermoformed workpiece onto the second thermoformed workpiece to form the composite article.
- [c2] The automated manufacturing line according to claim 1 wherein the assembly station assembles the first thermoformed workpiece to the second thermoformed workpiece by press-fitting the first and second thermoformed workpieces.
- [c3] The automated manufacturing line according to claim 2 wherein the press-fitting of the first and second thermoformed workpieces is a snap-fit.

- [c4] The automated manufacturing line according to claim 1 wherein the assembly station assembles the first thermoformed workpiece to the second thermoformed workpiece by an adhesive coupling.
- [c5] The automated manufacturing line according to claim 1 wherein the assembly station assembles the first thermoformed workpiece to the second thermoformed workpiece by an ultrasonic weld.
- [c6] The automated manufacturing line according to claim 1 wherein the assembly station comprises a carrier moveable between a first position, where it picks the first thermoformed workpiece, and a second position, where it assembles the first thermoformed workpiece to the second thermoformed workpiece.
- [c7] The automated manufacturing line according to claim 6 wherein the carrier comprises a suction device to pick the first thermoformed workpiece as it is trimmed from the sheet and hold the first thermoformed workpiece as it is carried to the second thermoformed workpiece.
- [c8] The automated manufacturing line according to claim 7 wherein the carrier comprises a force reliever to control the amount of force applied by the carrier to the first and second thermoformed workpieces as they are assem-

bled.

- [c9] The automated manufacturing line according to claim 8 wherein the carrier comprises a reciprocating arm on an end of which the suction device is mounted.
- [c10] The automated manufacturing line according to claim 9 wherein the force reliever mounts the suction device to the end of the arm.
- [c11] The automated manufacturing line according to claim 9 wherein the reciprocating arm reciprocates between a pick-up position that corresponds to the first position, and an assembly position that corresponds to the second position.
- [c12] The automated manufacturing line according to claim 11 wherein the reciprocating arm reciprocates between the pick-up and assembly positions in a direction that is either parallel or transverse to the machine direction as defined by the movement of the plastic sheet through the assembly station.
- [c13] The automated manufacturing line according to claim 11 wherein the trim station comprises a first punch and die set for trimming the first thermoformed workpiece from the plastic sheet.

- [c14] The automated manufacturing line according to claim 13 wherein the die comprises an inlet opening in which the punch is received to trim the first thermoformed workpiece from the plastic sheet when the plastic sheet is positioned between the punch and die, and an outlet opening into which the reciprocating arm extends to pick up the first thermoformed workpiece when the reciprocating arm is in the pick-up position.
- [c15] The automated manufacturing line according to claim 14 wherein the assembly station further comprises a moveable platform carrying the reciprocating arm and which is moveable between a first position where the reciprocating arm is positioned within the die outlet, and a second position where the reciprocating arm is positioned outside of the die outlet.
- [c16] The automated manufacturing line according to claim 15 wherein there are multiple reciprocating arms, with at least one of the arms at the pick-up position when another of the arms is at the assembly position providing for the contemporaneous pick-up of a first thermoformed workpiece while a previously pick-up first thermoformed workpiece is being assembled to the second thermoformed workpiece.
- [c17] The automated manufacturing line according to claim 16

wherein the trim station further comprises a second punch and die set for trimming the assembled first and second thermoformed workpieces from the plastic sheet.

- [c18] The automated manufacturing line according to claim 6 wherein there are multiple carriers.
- [c19] The automated manufacturing line according to claim 18 wherein the multiple carriers are arranged in at least two sets, wherein when one of the at least two sets is in the first position, the other of the at least two sets is in the second position providing for the contemporaneous pick-up of a first thermoformed workpiece while a previously pick-up first thermoformed workpiece is being assembled to the second thermoformed workpiece.
- [c20] The automated manufacturing line according to claim 6 wherein the movement of the carriers between the first and second positions is either generally parallel or transverse to the machine direction as defined by the movement of the plastic sheet through the assembly station.
- [c21] The automated manufacturing line according to claim 6 wherein the trim station comprises a first punch and die set for trimming the first thermoformed workpiece from the plastic sheet.
- [c22] The automated manufacturing line according to claim 21

wherein the die comprises an inlet opening in which the punch is received to trim the first thermoformed workpiece from the plastic sheet when the plastic sheet is positioned between the punch and die, and an outlet opening into which the carrier extends to pick up the first thermoformed workpiece.

[c23] The automated manufacturing line according to claim 21 wherein the trim station further comprises a second punch and die set for trimming the assembled first and second thermoformed workpieces from the plastic sheet.

[c24] The automated manufacturing line according to claim 1 wherein the assembly station moves the first thermoformed workpiece directly from the trim station onto the second thermoformed workpiece eliminating the need to temporarily store the first thermoformed workpiece prior to assembly to the second thermoformed workpiece.

[c25] An apparatus for automatically forming a composite article by assembling first and second workpieces thermoformed in a common plastic sheet comprising a plurality of the first and second work pieces, the assembly station comprising:
a trimmer for trimming at least one of the first workpieces from the plastic sheet; and
a carrier moveable between a first position, where the

carrier picks up one of the first workpieces, and a second position, where the carrier assembles the first workpiece to one of the second workpieces in the plastic sheet.

[c26] The apparatus according to claim 25 wherein the carrier moves directly between the first and second positions eliminating the need to temporarily store the first workpiece prior to assembly to the one of the second workpieces.

[c27] The apparatus according to claim 26 wherein the carrier assembles the first workpiece to the one of the second workpieces by a press-fit coupling.

[c28] The apparatus according to claim 27 wherein the carrier comprises a suction device to pick the first workpiece as it is trimmed from the sheet and to hold the first workpiece as it is assembled to the second workpiece.

[c29] The apparatus according to claim 28 wherein the carrier comprises a force reliever to control the amount of force applied by the carrier to the second workpiece during the assembly of the first workpiece to the second workpiece.

[c30] The apparatus according to claim 29 wherein the carrier comprises a reciprocating arm on an end of which the suction device is mounted.

- [c31] The apparatus according to claim 30 wherein the force reliever mounts the suction device to the end of the arm.
- [c32] The apparatus according to claim 31 wherein the reciprocating arm reciprocates between a pick-up position that corresponds to the first position, and an assembly position that corresponds to the second position.
- [c33] The apparatus according to claim 32 wherein the reciprocating arm reciprocates between the pick-up and assembly positions in a direction that is either parallel or transverse to the machine direction as defined by the movement of the plastic sheet through the assembly station.
- [c34] The apparatus according to claim 33 wherein the trimmer comprises a first punch and die set for trimming the first workpiece from the plastic sheet.
- [c35] The apparatus according to claim 34 wherein the die comprises an inlet opening in which the punch is received to trim the first workpiece from the plastic sheet when the plastic sheet is positioned between the punch and die, and an outlet opening into which the reciprocating arm extends to pick up the first workpiece when the reciprocating arm is in the pick-up position.

- [c36] The apparatus according to claim 35 wherein the assembly station further comprises a moveable platform carrying the reciprocating arm and which is moveable between a first position where the reciprocating arm is positioned within the die outlet, and a second position where the reciprocating arm is positioned outside of the die outlet.
- [c37] The apparatus according to claim 36 wherein there are multiple reciprocating arms, with at least one of the arms at the pick-up position when another of the arms is at the assembly position.
- [c38] The apparatus according to claim 37 and further comprising a second trimmer having a second punch and die set for trimming the assembled first and second workpieces from the plastic sheet.
- [c39] The apparatus according to claim 25 wherein there are multiple carriers, with each carrier picking up a different first workpiece in the first position and assembling it to a different second workpiece.
- [c40] The apparatus according to claim 25 wherein the carrier assembles the first workpiece to the second workpiece by a press-fit coupling.
- [c41] The apparatus according to claim 40 wherein the press-

fit coupling is a snap-fit coupling.

- [c42] The apparatus according to claim 25 wherein the assembly station assembles the first workpiece to the second workpiece by an adhesive coupling.
- [c43] The apparatus according to claim 25 wherein the assembly station assembles the first workpiece to the second workpiece by an ultrasonic weld.
- [c44] A method for automatically assembling a first thermoformed workpiece to a second thermoformed workpiece from a plastic sheet comprising a plurality of the first thermoformed workpieces and a plurality of the second thermoformed workpieces to form a composite thermoformed article, comprising:
trimming at least one of the first thermoformed workpieces from the plastic sheet to form at least one trimmed first thermoformed workpiece;
immediately after trimming, carrying the trimmed first thermoformed workpiece to a corresponding second thermoformed workpiece; and
assembling the trimmed first thermoformed workpiece to the corresponding second thermoformed workpiece to form a composite thermoformed article.
- [c45] The method of claim 44 wherein the assembling of the

trimmed first thermoformed workpiece comprises bonding the trimmed first thermoformed workpiece to the corresponding second thermoformed workpiece.

[c46] The method of claim 44 wherein the assembling of the trimmed first thermoformed workpiece comprises welding the trimmed first thermoformed workpiece to the corresponding second thermoformed workpiece.

[c47] The method of claim 44 wherein the assembling of the trimmed first thermoformed workpiece comprises press-fitting together the trimmed first thermoformed workpiece and the corresponding second thermoformed workpiece.

[c48] The method of claim 47 wherein the press-fitting together comprises snap-fitting the trimmed first thermoformed workpiece to the corresponding second thermoformed workpiece.

[c49] The method of claim 47 wherein the carrying of the trimmed first thermoformed workpiece comprises picking-up the trimmed thermoformed workpiece by suction.

[c50] The method of claim 49 wherein the carrying of the trimmed first thermoformed workpiece further comprises stopping the suction at the completion of the assembly of the trimmed first thermoformed workpiece to

the corresponding second thermoformed workpiece.

- [c51] The method of claim 49, and further comprising limiting the force applied to the trimmed first thermoformed workpiece and the corresponding second thermoformed workpiece as the trimmed first thermoformed workpiece is assembled to the corresponding second thermoformed workpiece.
- [c52] The method of claim 44 wherein the trimming step comprises the trimming of multiple first thermoformed workpieces to form multiple trimmed first thermoformed workpieces, and the assembling step comprises assembling each of the multiple first thermoformed workpieces to a corresponding second thermoformed workpiece to form multiple composite thermoformed articles.
- [c53] The method of claim 52 wherein the trimming of multiple first thermoformed workpieces comprises trimming a subset of the total number of first thermoformed workpieces from the plastic sheet.
- [c54] The method of claim 53 wherein the first thermoformed workpieces forming the subset are all trimmed simultaneously from the plastic sheet.
- [c55] The method of claim 54 wherein the first thermoformed workpieces forming the subset are all simultaneously as-

sembled to corresponding second thermoformed workpieces.

- [c56] The method of claim 53 and further comprising thermoforming the first and second thermoformed workpieces in a repeating pattern of a predetermined unit.
- [c57] The method of claim 56 wherein the subset is an integer multiple of the predetermined unit.
- [c58] The method of claim 57 wherein the predetermined unit is one of a row or a column.
- [c59] The method of claim 58 wherein the first and second workpieces are arranged in alternating rows or columns.
- [c60] The method of claim 59 wherein the first thermoformed workpiece is trimmed from one of the alternating rows or columns and assembled onto the second thermoformed workpieces in the adjacent row or column.
- [c61] The method of claim 60 and further comprising trimming the composite thermoformed articles from the plastic sheet.
- [c62] The method of claim 53 wherein the thermoforming of the first workpiece comprises thermoforming a closure tab having first and second projections connected by a flexible strap, the thermoforming of the second work-

piece comprises thermoforming a lid having body recess and a drink opening, wherein the snap-fitting comprises inserting the first projection into the body recess and inserting the second projection into the drink opening.

- [c63] A method for automatically assembling a first thermoformed workpiece to a second thermoformed workpiece from a plastic sheet comprising a plurality of the first thermoformed workpieces and a plurality of the second thermoformed workpieces to form a composite thermoformed article, comprising:
- trimming at least one of the first thermoformed workpieces from the plastic sheet to form at least one trimmed first thermoformed workpiece;
 - carrying the trimmed first thermoformed workpiece to a corresponding second thermoformed workpiece; and
 - press-fitting the trimmed first thermoformed workpiece to the corresponding second thermoformed workpiece to form a composite thermoformed article.
- [c64] The method of claim 63 and further comprising the thermoforming of the first and second thermoformed workpieces in the plastic sheet such that one of the first and second workpieces has a projection and the other has a recess, and the press-fitting comprising inserting the projection into the recess.

- [c65] The method of claim 64 wherein the press-fitting together comprises snap-fitting the projection into the recess.
- [c66] The method of claim 65 wherein the projection has a portion of greater size than a portion of the recess to effect the snap fit.
- [c67] The method of claim 66 wherein there are multiple corresponding pairs of projections and recesses.
- [c68] The method of claim 67 wherein the thermoforming of the first workpiece comprises thermoforming a closure tab having first and second projections connected by a flexible strap, the thermoforming of the second workpiece comprises thermoforming a lid having body recess and a drink opening, wherein the snap-fitting comprises inserting the first projection into the body recess and inserting the second projection into the drink opening.
- [c69] The method of claim 63 wherein the carrying of the trimmed first thermoformed workpiece comprises picking-up the trimmed thermoformed workpiece by suction.
- [c70] The method of claim 63, and further comprising limiting the force applied to the trimmed first thermoformed workpiece and the corresponding second thermoformed workpiece as the trimmed first thermoformed workpiece

is press-fit to the corresponding second thermoformed workpiece.

- [c71] The method of claim 63 wherein the trimming step comprises the trimming of multiple first thermoformed workpieces to form multiple trimmed first thermoformed workpieces, and the press-fitting comprises press-fitting each of the multiple first thermoformed workpieces to a corresponding second thermoformed workpiece to form multiple composite thermoformed articles.
- [c72] The method of claim 71 wherein the trimming of multiple first thermoformed workpieces comprises trimming a subset of the total number of first thermoformed workpieces from the plastic sheet.
- [c73] The method of claim 72 wherein the first thermoformed workpieces forming the subset are all trimmed simultaneously from the plastic sheet.
- [c74] The method of claim 73 wherein the first thermoformed workpieces forming the subset are all simultaneously press-fit to corresponding second thermoformed workpieces.
- [c75] The method of claim 63 and further comprising thermoforming the first and second thermoformed workpieces in a repeating pattern of a predetermined unit in the

plastic sheet.

- [c76] The method of claim 75 wherein the subset is an integer multiple of the predetermined unit.
- [c77] The method of claim 76 wherein the predetermined unit is one of a row or a column.
- [c78] The method of claim 77 wherein the first and second workpieces are arranged in alternating rows or columns.
- [c79] The method of claim 78 wherein the first thermoformed workpiece is trimmed from one of the alternating rows or columns and assembled onto the second thermoformed workpieces in the adjacent row or column.
- [c80] The method of claim 79 and further comprising trimming the composite thermoformed articles from the plastic sheet.
- [c81] The method of claim 75 wherein the thermoforming comprises forming the sheet from a web of plastic.